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16. ABSTRACT

The U.S. Environmental Protection Agency's intercomparison studies program for laboratories involved in environmental radiation measurements is described. The types of environmental samples distributed, the analysis required for each sample, the distribution schedule, and the statistical analysis and reporting of results are discussed. Instructions and application forms are included for laboratories desiring to participate in the program.

This document is not a research report. It is designed for use by laboratories participating or desiring to participate in this quality assurance program.

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Environmental Monitoring and Support Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Las Vegas, Nevada 89114

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January 1977

ENVIRONMENTAL RADIOACTIVITY
LABORATORY INTERCOMPARISON STUDIES PROGRAM
FY 1977

by

Quality Assurance Branch
Monitoring Systems Research and Development Division
Environmental Monitoring and Support Laboratory
Las Vegas, Nevada 89114

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY
LAS VEGAS, NEVADA 89114

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PREFACE

Quality assurance is an integral part of any viable environmental monitoring activity. The primary goals of the U.S. Environmental Protection Agency's (EPA) quality assurance program are to improve and document the credibility of environmental measurements. To achieve these goals, quality assurance is needed in nearly all segments of monitoring activities and should cover personnel, methods selection, equipment, and data handling procedures.

Five major functions, each essential to an effective quality assurance effort, comprise EPA's quality assurance program.

- Promulgation of standardized methods of measurement
- Distribution of standard reference materials
- Issuance of guidelines and procedures
- Training and technical assistance
- Evaluation and certification of monitoring activities

This manual has been prepared to assist laboratories involved with environmental radiation measurements in developing and maintaining a quality control program and documenting the precision and accuracy of their data. All EPA monitoring programs are requested to make use of this document in planning their own radiation measurements and in assisting the States in carrying out radiation monitoring activities.

Comments concerning the utility of this document, along with any suggestions for possible changes and revisions, are welcomed. Questions on matters related to quality assurance of environmental measurements in various fields should be directed to the following person(s):

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Las Vegas, Nevada 89114

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Quality Assurance Branch
Environmental Monitoring and Support Laboratory
Cincinnati, Ohio 45268

Periodically, manuals and documents will be issued which provide guidelines to be followed in all phases of monitoring activities. Use of these guidelines throughout the Agency will enable a uniform approach to be established within EPA which ultimately can be implemented at the State level. This should permit a significant improvement in the validity and reliability of environmental data collected throughout the Nation.

The implementation of a total and meaningful national environmental quality assurance effort cannot succeed without the full support of all monitoring programs. Your cooperation is appreciated.

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THE LABORATORY INTERCOMPARISON STUDIES PROGRAM

Environmental measurements of radiation are made daily by many Federal, State, local, and private agencies. The data from these measurements are used for a wide variety of purposes including assessment of health effects, the establishment of standards and guides, and for enforcement activities. It is therefore imperative that the precision and accuracy of the data be assured in order that policy decisions concerning environmental quality are based on valid and comparable data of known reliability.

In order to attain this goal, an Agency-wide quality assurance program has been implemented within the U.S. Environmental Protection Agency (EPA). In the area of radiation, quality control responsibilities have been assigned to the Quality Assurance Branch at the EPA's Environmental Monitoring and Support Laboratory-Las Vegas which carries out a program designed to encourage the development and implementation of quality control procedures for sample collection, laboratory analysis, and data handling and reporting.

A major objective of this program is to assist laboratories involved in environmental radiation measurements to develop and maintain both an intralaboratory and an interlaboratory quality control program. In part, this is accomplished through an extensive laboratory intercomparison study ("crosscheck") program involving environmental media (milk, water, air, food, soil, and gases) and a variety of radionuclides with activities at or near environmental levels.

Simulated environmental samples, containing known amounts of one or more radionuclides, are prepared and routinely distributed to all laboratories upon request. These laboratories perform the required analyses and return their data to the Quality Assurance Branch for statistical analysis and comparison with known values and analytical values obtained by other participating laboratories. A report and a control chart are returned to each participant. The program thus enables each laboratory to document the precision and accuracy of its radiation data, identify instrument and procedural problems, and to compare its performance with that of other laboratories.

Each laboratory making environmental measurements for radiation should have an internal quality control program in operation to insure that all instrumentation is calibrated and functioning, and that analytical procedures are being carried out properly. Such a program includes continual monitoring of instrumentation, the plotting of instrument control charts, frequent analysis of replicate samples to check precision, and the regular measurement of samples to which known amounts of activity have been added to check the accuracy of systems.

Participation in a laboratory intercomparison study does not automatically assure the precision and accuracy of a laboratory's data and should not be

considered as a substitute for a continuous quality control program within a laboratory. Intercomparison data may be useful for documenting precision and accuracy, and helping to indicate instrument or procedural problems. Participation in intercomparison studies is useful in augmenting a laboratory's quality control program by serving as a check on its internal quality control program.

You are encouraged to have your laboratory participate or expand participation in the cross-check program of the Quality Assurance Branch of the EMSL-LV's Monitoring Systems Research and Development Division.

TYPES OF ENVIRONMENTAL SAMPLES DISTRIBUTED

The current laboratory intercomparison studies program covers the analysis of a variety of media containing various levels of radioactivity. These include:

Milk: Four-liter milk samples containing potassium, strontium-89, strontium-90, iodine-131, cesium-137, and barium-140 are distributed on a bimonthly basis.

Water: Water containing several different mixtures of radioactive materials is included in the cross-check program.

- Four-liter samples for the analysis of gross alpha and gross beta activity are sent bimonthly to participating laboratories.
- Four-liter samples containing chromium-51, zinc-65, cobalt-60, ruthenium-106, cesium-134, and cesium-137 are distributed bimonthly for analysis of gamma emitters.
- Fifty-milliliter samples for tritium analysis are distributed on a bimonthly basis.
- Four-liter water samples containing plutonium-239 are shipped to laboratories twice a year.
- Four-liter samples of well water containing radium-226 and/or radium-228 are distributed four times a year.

Air: Three 2-inch-diameter air filters are sent out on a quarterly basis for gross alpha, gross beta, plutonium-239, cesium-137, and strontium-90 analysis.

Soil: Thirty-five-gram soil samples, containing plutonium-239 and plutonium-238 or thorium-228, thorium-230 and thorium-232, are distributed twice each year.

Food: Two 4-liter food slurries containing strontium-89, strontium-90, iodine-131, cesium-137, barium-140, and potassium are sent to participants quarterly.

Urine: Fifty-milliliter urine samples containing tritium are shipped on a quarterly basis.

Gases: One-liter, steel, gas cylinders, containing 10 liters (S.T.P.) of krypton-85, are distributed four times each year.

Sample size, approximate activity levels, type of analysis, and other pertinent information concerning the cross-check samples are summarized in Table 1. The distribution schedule is outlined in Table 2.

A laboratory may participate in any one or all of the studies described.

ANALYSIS OF DATA

Each participating laboratory is expected to carry out three independent determinations for each radionuclide included in a particular cross-check study and to report its results on a form (Figure 1) provided with the sample.

Upon receipt of the reports from all participating laboratories, the data are transferred to punch cards for computer analysis. As indicated in the sample calculations, this analysis includes determination of the laboratory standard deviation, calculation of the normalized range, normalized deviation, sample standard deviation, and the grand average of all laboratories. The analytical precision values, used as a basis for judging laboratory performance for specific nuclides, are summarized in Table 3.

A report is generated containing data reported by participating laboratories, listed according to their identity code, along with the results of the analysis (Figure 2). In addition, a control chart is generated and reproduced for each radionuclide included in the sample (Figure 3). The control charts are updated each time a laboratory participates in a particular cross-check study, thus giving each laboratory a continuous record of its performance.

A letter giving the known value for each radionuclide is mailed to participants approximately 2 weeks after the report due date. This is followed by a complete report which includes a copy of the computer printout and control chart.

PARTICIPATION IN THE LABORATORY INTERCOMPARISON STUDIES PROGRAM

Any laboratory involved in, or concerned with, environmental radiation monitoring and surveillance is eligible to participate in any one or all of the cross-checks described. Moreover, dependent upon personnel available and

their workload, a laboratory may elect to receive samples on a less frequent basis than indicated on the distribution schedule (Table 2).

To become a participant in the laboratory intercomparison studies program, complete one of the forms included at the end of this publication and return to:

U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Should the laboratory require additional types of cross-check samples at some later date, a second form indicating the samples desired should be submitted.

STATISTICAL CALCULATIONS

To illustrate the computations performed by the computer, example calculations are given using data for three samples analyzed at one laboratory (Laboratory D, see Figure 2).

The experimental data are listed and the mean, experimental sigma and range are computed. These statistics provide measures of the central tendency and dispersion of the data.

The normalized range is computed by first finding the mean range, $\bar{R}$, the control limit, CL, and the standard error of the range, σ_R. The normalized range measures the dispersion of the data (precision) in such a form that control charts may be used. Control charts allow one to readily compare past analytical performance with present performance. In the example, the normalized range equals 0.3 which is less than 3, which is the upper warning level. The precision of the results is acceptable.

The normalized deviation is calculated by computing the deviation and the standard error of the mean, σ_m. The normalized deviation allows one to readily measure central tendency (accuracy) through the use of control charts. Trends in analytical accuracy can be determined in this manner. For this example, the normalized deviation is -0.7 which falls between +2 and -2, which are the upper and lower warning levels. The accuracy of the data is acceptable.

Finally, the experimental error of all laboratories, the grand average, and the normalized deviation from the grand average are calculated in order to ascertain the performance of all the laboratories as a group. Any bias in methodology or instrumentation may be found from these results.

EXAMPLE CALCULATIONS (Laboratory D Data, see Figure 2)

Experimental data:

Known value = μ = 3273 pCi ^{3}H/liter urine on September 24, 1974

Expected laboratory precision = σ = 357 pCi/liter

Laboratory	Sample	Result
D	x_1	3060 pCi/liter
D	x_2	3060 pCi/liter
D	x_3	3240 pCi/liter

Mean = $\bar{x}$

$$\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N} = \frac{9360}{3} = 3120 \text{ pCi/liter}$$

where N = number of results = 3

Experimental sigma = s

$$s = \sqrt{\frac{\sum_{i=1}^{N} (x_i)^2 - \frac{\left(\sum_{i=1}^{N} x_i\right)^2}{N}}{N - 1}}$$

$$s = \sqrt{\frac{(3060)^2 + (3060)^2 + (3240)^2 - \frac{(3060 + 3060 + 3240)^2}{3}}{2}}$$

= 103.9 pCi/liter

Range = r

r = |maximum result - minimum result|

= |3240 - 3060| = 180 pCi/liter

Range Analysis (RNG ANLY)*

Mean range = $\bar{R}$

$\bar{R} = d_2\sigma$ where $d_2^* = 1.693$ for N = 3

$= (1.693)(357)$

$= 604.4$ pCi/liter

Control limit = CL

$CL = \bar{R} + 3\sigma_R$

$= D_4\bar{R}$ where $D_4^* = 2.575$ for N = 3

$= (2.575)(604.4)$

$= 1556$ pCi/liter

Standard error of the range = σ_R

$\sigma_R = (\bar{R} + 3\sigma_R - \bar{R}) \div 3$

$= (D_4\bar{R} - \bar{R}) \div 3$

$= (1556 - 604.4) \div 3$

$= 317.2$ pCi/liter

Let range = $r = w\bar{R} + x\sigma_R = 180$ pCi/liter

Define normalized range = $w + x$

for $r > \bar{R}$, $w = 1$

then $r = w\bar{R} + x\sigma_R = \bar{R} + x\sigma_R$

or $x = \dfrac{r - \bar{R}}{\sigma_R}$

therefore $w + x = 1 + x = 1 + \dfrac{r - \bar{R}}{\sigma_R}$

---

* Rosenstein, M., and A. S. Goldin, *Statistical Techniques for Quality Control of Environmental Radioassay*, AQCS Report Stat-1, U.S. Department of Health, Education and Welfare, PHS, Nov 1964

for $r \leq \bar{R}$, $x = 0$

then $r = w\bar{R} + x\sigma_R = w\bar{R}$

or $w = \frac{r}{\bar{R}}$

therefore $w + x = w + 0 = \frac{r}{\bar{R}}$

since $r < \bar{R}$ $(180 < 604.4)$

$$w + x = \frac{180}{604.4}$$

$$= 0.30$$

Normalized deviation of the mean from the known value = ND

Deviation of mean from the known value = D

$$D = \bar{x} - \mu$$

$$= 3120 - 3273$$

$$= -153 \text{ pCi/liter}$$

Standard error of the mean = σ_m

$$\sigma_m = \frac{\sigma}{\sqrt{N}}$$

$$= \frac{357}{\sqrt{3}}$$

$$= 206.1 \text{ pCi/liter}$$

$$ND = \frac{D}{\sigma_m}$$

$$= \frac{-153}{206.1}$$

$$= -0.7$$

Experimental sigma (all laboratories) = s_t (See Figure 2)

$$s_t = \sqrt{\frac{\sum_{i=1}^{N} (x_i)^2 - \frac{\left(\sum_{i=1}^{N} x_i\right)^2}{N}}{N - 1}}$$

$$= \sqrt{\frac{162639133 - \frac{(49345)^2}{15}}{14}}$$

$$= 149 \text{ pCi/liter}$$

Grand average = GA

$$= \frac{\sum_{i=1}^{N} x_i}{N}$$

$$= \frac{49345}{15}$$

$$= 3290 \text{ pCi/liter}$$

Normalized deviation from the grand average = ND'

Deviation of the mean from the grand average = D'

$$D' = \bar{x} - GA$$

$$= 3120 - 3290$$

$$= - 170 \text{ pCi/liter}$$

$$ND' = \frac{D'}{\sigma_m}$$

$$= \frac{- 170}{206.1}$$

$$= - 0.8$$

TABLE 1. SUMMARY OF CROSS-CHECK PROGRAMS*

SAMPLE	ANALYSIS	ACTIVITY PER ISOTOPE	QUANTITY SUPPLIED	PRESERVATIVE	DISTRIBUTION	TIME FOR ANALYSIS & REPORT
Milk	^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{140}Ba, K	< 200 pCi/liter	∿ 4 liters	Formalin	Bimonthly	6 weeks
Water						
Gross α, β*	Gross α, β	< 100 pCi/liter	∿ 4 liters	0.5N HNO_3	Bimonthly	4 weeks
Gamma	^{60}Co, ^{106}Ru, ^{134}Cs, ^{137}Cs, ^{51}Cr, ^{65}Zn	< 500 pCi/liter	∿ 4 liters	0.5N HNO_3	Bimonthly	4 weeks
^{3}H	^{3}H	< 3500 pCi/liter	∿ 50 ml	none	Bimonthly	4 weeks
^{239}Pu*	^{239}Pu	< 10 pCi/liter	∿ 4 liters	0.5N HNO_3	Semiannually	8 weeks
Radium	^{226}Ra, ^{228}Ra	< 20 pCi/liter	∿ 4 liters	0.5N HNO_3	Quarterly	6 weeks
Air						
Gross α, β*	α, β, ^{90}Sr, ^{137}Cs	< 200 pCi/sample	3 - 2"-diam. air filters	none	Quarterly	6 weeks
^{239}Pu*	^{239}Pu	< 2 pCi/sample	3 - 2"-diam. air filters	none	Quarterly	6 weeks
Soil*	^{238}Pu, ^{239}Pu ^{228}Th, ^{230}Th, ^{232}Th	< 50 pCi/sample	∿ 35 grams	none	Semiannually	8 weeks
Diet	^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{140}Ba, K	< 200 pCi/kg	2 - 4-liter samples	Formalin	Quarterly	8 weeks
Urine	^{3}H	< 3500 pCi/liter	∿ 50 ml	Formalin	Quarterly	4 weeks
Gas	^{85}Kr	< 20 pCi/ml	10 liters	none	Quarterly	6 weeks

* Laboratories are required to have the necessary licenses before receiving these samples.

TABLE 2. CROSS-CHECK SAMPLE DISTRIBUTION SCHEDULE
(Numbers indicate week of the month)

Month in FY-77	Milk	Water					Air Filter	Soil	Diet	Urine	Gas
	Sr, γ	Gross α, β	γ	^{3}H	^{239}Pu	^{226}Ra, ^{228}Ra	Gross α, β, ^{239}Pu, ^{90}Sr, ^{137}Cs	Plutonium Thorium	Sr, γ	^{3}H	^{85}Kr
1976											
Oct			1	2							3
Nov	1	3						2[d]	4		
Dec			1	2		3[a]	4[b]			2	
1977											
Jan	1	3			2						4
Feb			1	2					3		
Mar	1	3				2[a]	4[c]			3	
Apr			1	2							4
May	1	3						2[e]	4		
Jun			1	2		3[a]	4[b]			2	
Jul	1	3			2						4
Aug			1	2					3		
Sep	1	3				2	4[c]			3	

a. ^{226}Ra analysis only
b. α, β, ^{137}Cs & ^{90}Sr analysis
c. α, β, ^{137}Cs & ^{239}Pu analysis
d. Thorium analysis only
e. Plutonium analysis only

TABLE 3. LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES

Analysis	Level	Standard Deviation Single Determination
Gamma Emitters	5 to 100 pCi/liter or kg >100 pCi/liter or kg	5 pCi/liter 5% of known value
Strontium-89	5 to 100 pCi/liter or kg >100 pCi/liter or kg	5 pCi/liter 5%
Strontium-90	2 to 30 pCi/liter or kg >30 pCi/liter or kg	1.5 pCi/liter 5%
Pocassium	$\geq$ 0.1 g/liter or kg	5%
Gross Alpha	$\leq$ 20 pCi/liter > 20 pCi/liter	5 pCi/liter 25%
Gross Beta	$\leq$ 100 pCi/liter >100 pCi/liter	5 pCi/liter 5%
Tritium	< 4000 pCi/liter $\geq$ 4000 pCi/liter	ls (pCi/liter) = 169.85 × (known)$^{.0933}$ 10%
Radium-226, Radium-228	$\geq$ 0.1 pCi/liter	15%
Plutonium, Thorium Isotopes	$\geq$ 0.1 pCi/liter, gram or sample	10%
Krypton-85	5 to 100 pCi/ml (S.T.P.)	10%

U.S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY
P.O. BOX 15027
LAS VEGAS, NEVADA 89114
702/736-2969

QUALITY ASSURANCE BRANCH
ANALYSIS RESULTS
TRITIUM IN URINE CROSS-CHECK PROGRAM

Laboratory _____

_____

_____

Contact Person _____

Phone _____ Collection Date _____

IMPORTANT: Report results corrected for decay as of the collection date.

Please refer to instructions on back of page.

	LAB CODE		DO NOT USE THIS SPACE					ISOTOPE	ANALYSIS #1												ANALYSIS #2												ANALYSIS #3												UNITS
	1	2	3	4	5	6	7		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40					
1							1	3H										•										•										•					pCi/l

In order to be included in the final report, please send your results no later than _____ to:

U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch (MSQ)
P.O. Box 15027
Las Vegas, NV 89114

Figure 1. Results report form

REPORT SHEET INSTRUCTIONS

1. Legibly type or print numbers and letters in the proper squares. Use only capital letters.

2. Record lab code in columns 1 and 2 for each isotope (one isotope per line). For a code of only one letter, use column 1.

3. Slash the letters Ø and B. Do not slash any numbers.

4. Do not use columns 3-7; they are for internal use only.

5. Data entry: (columns 11-40)

   a. All numbers must be right justified (entered to far right of field).

   b. For statistical purposes, it is important that each laboratory report three results for each radionuclide. If, for some unavoidable reason, less than three values are reported, record the data starting with the columns reserved for analysis #1 and work to the right.

   c. Report results to the nearest whole number with the exceptions of tritium and potassium (each recorded to multiples of ten) and radium-226 (recorded to one decimal place). Decimal points are provided on the report forms.

   d. Each line of the coding form contains the name of the isotope and its unit of activity, preprinted for your convenience. Each line should contain information pertaining to just that one isotope.

   e. If a value is less than (LT) the minimum detectable activity (MDA), record LT, space, then the MDA value (right justified).

Figure 1 (continued). Results report form

EMSL-LV TRITIUM IN URINE CROSS-CHECK PROGRAM --- SEPTEMBER 1974

09/20/74 SAMPLE - A 3H

KNOWN VALUE - 3273 PCI/L

EXPECTED LABORATORY PRECISION (1S, 1 DETERMINATION) - 357 PCI/L

LAB	RESULT	EXPERIMENTAL SIGMA	RNG ANLY ($\bar{R}$ = SR)	AVERAGE	NORMALIZED DEVIATION (GRAND AVG)	(KNOWN)
AN	NO DATA PROVIDED					
CF	3269					
CF	3522					
CF	3632	186.1	.60	3474	.9	1.0
CM	3261					
CM	3373					
CM	3362	61.7	.19	3332	.2	.3
CO	NO DATA PROVIDED					
D	3060					
D	3060					
D	3240	103.9	.30	3120	-.8	-.7
J	3255					
J	3247					
J	3294	25.1	.08	3265	-.1	-.0
P	NO DATA PROVIDED					
Z	3240					
Z	3340					
Z	3190	76.4	.25	3257	-.2	-.1

EXPERIMENTAL SIGMA (ALL LABS) - 149 GRAND AVERAGE - 3290

Figure 2. Sample analysis and report of participant's data

Explanation of terms in Figure 2:

Title:	Program name, sample collection date, sample code letter, analysis type, known concentration of radionuclide, expected standard deviation of analysis - single determination.
Column 1:	Laboratory identification code (A, B, C, etc.).
Column 2:	Laboratory results (0-25 results listed down column).
Column 3:	1s (standard deviation) of the experimental results.
Columns 4 and 5:	Normalized range value in "mean range + standard error of the range" ($\bar{R} + \sigma_R$) units for comparability. (See *Statistical Techniques for Quality Control of Environmental Radioassay*, AQCS Report Stat-1, November 1964, pages 4-8.) ($S_R = \sigma_R$ for printing purposes.)
Column 6:	Average value.
Column 7:	Normalized deviation from the grand average value of all laboratories expressed in σ_M units.
Column 8:	Normalized deviation from the known value expressed in σ_M units.
Bottom of Chart:	1s experimental error of all laboratories, and the grand average of all laboratories.

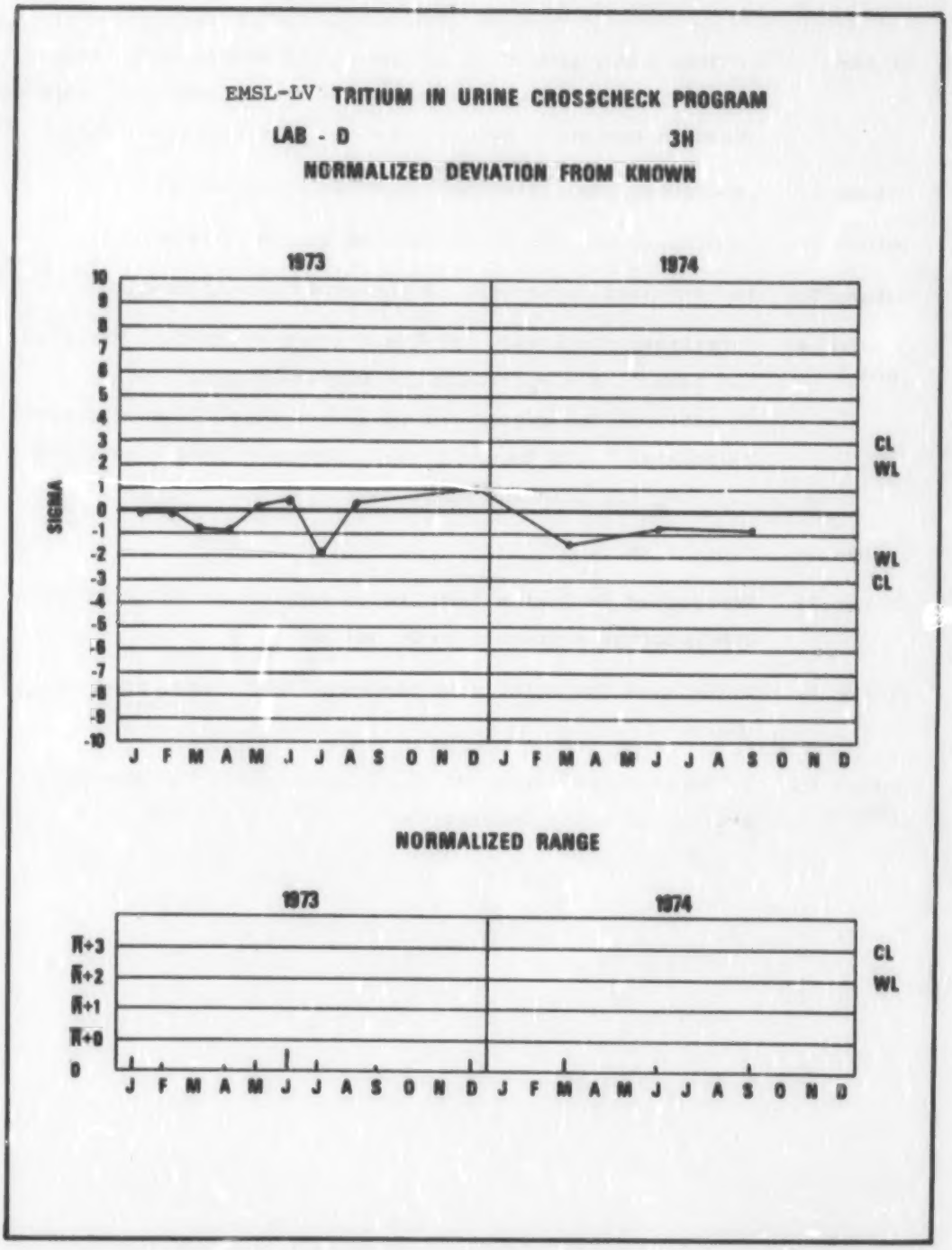

Figure 3. Control chart

Explanations of terms used in the control chart (Figure 3).

Title:	Name of program, laboratory code letter, and type of analysis.
Upper Graph:	"Normalized deviation from known versus the month of analysis." [The 95.0% ($\mu \pm 2\sigma_M$) and the 99.7% ($\mu \pm 3\sigma_M$) confidence levels were chosen as the warning levels and control limits respectively.]
Lower Graph:	"Normalized range values ($\bar{R} + \sigma_R$) versus the month of analysis." [The 97.5% ($\bar{R} + 2\sigma_R$) and ∿100% ($\bar{R} + 3\sigma_R$) confidence levels were chosen as the warning levels and control limits respectively.]

SUBJECT: Participation in Intercomparison Studies Program

TO: U.S. Environmental Protection Agency
Environmental Monitoring and Support Laboratory
Quality Assurance Branch
P.O. Box 15027
Las Vegas, NV 89114

Please include our laboratory in the cross-check studies we have indicated below. All samples are to be shipped to:

Contact Person _____

Title _____

Laboratory _____

Address _____

NRC License and/or State License Type(s) _____

Number(s) _____

NOTE: When requesting participation in a study containing either nuclear byproducts or special nuclear materials, a copy of the NRC license(s) must accompany the request.

If your laboratory prefers participation other than the published frequency, please indicate months samples are desired.

SAMPLE TYPES	FREQUENCY DESIRED: BIMONTHLY	QUARTERLY	SEMIANNUALLY	ANNUALLY
Milk: Sr, γ	☐	☐	☐	☐
Water:				
Gross α, β	☐	☐	☐	☐
γ	☐	☐	☐	☐
^{3}H	☐	☐	☐	☐
^{239}Pu			☐	☐
^{226}Ra, ^{220}Ra		☐	☐	☐
Diet: Sr, γ		☐	☐	☐

SAMPLE TYPES	FREQUENCY DESIRED: QUARTERLY	SEMIANNUALLY	ANNUALLY
Air Filter:			
Gross α, β	☐	☐	☐
^{239}Pu	☐	☐	☐
Soil:			
Pu Isotopes			☐
Th Isotopes			☐
Urine: ^{3}H	☐	☐	☐
Gases: ^{85}Kr	☐	☐	☐

I certify this laboratory is authorized to receive the samples requested.

Signature _____

Date _____ Title _____